IN THE SPECIFICATION:

On page 1 immediate following the title, please insert headings as follows:

BACKGROUND OF THE INVENTION

Field of the Invention

The paragraph beginning on page 1, line 1 has been changed as follows:

The ~~present~~ invention relates to droplet deposition apparatus and in particular drop on demand ink jet printers, components therefor, and their manufacture.

On page 1, after line 3 please insert a heading as follows:

Related Technology

The paragraphs beginning on page 1, line 17 have been changed as follows:

One particularly elegant form of an actuator is one produced and made commercially available by ~~the applicant company~~ Xaar Technology Limited under the product code XJ500. Channels are sawn into the piezoelectric material such that they are bounded on either side by a wall. A cover plate is provided to close the top surface of the channels and a nozzle plate is attached to the open front of the channel. Nozzles are formed extending through the nozzle plate and communicate with the channels. Electrical voltages applied across the walls cause the walls to deflect in shear. The deflection pressurises ink in the channel and causes a droplet to be ejected through the nozzle.

It has been proposed to ~~mould~~ mold a piezoelectric print head and certain structures are proposed. One structure is proposed in WO 00/16981 relating to a circular chamber having a lower wall of piezoelectric material formed by ~~moulding~~ molding.

~~Whilst~~ While forming an actuator by ~~moulding~~ molding is quick, some accuracy is lost over the traditional mechanical sawing methods. In particular, the piezoelectric material shrinks on firing often up to 30%. This shrinkage is not uniform across the piezoelectric material and this leads to actuators having different channel spacing along the length of the array.

On page 2, after line 9, please insert a heading as follows:

GENERAL DESCRIPTION OF THE INVENTION

The paragraphs beginning on page 2, line 10 have been changed as follows:

The ~~present~~ invention seeks to address this and other problems.

According to one aspect of the ~~present~~ invention there is provided an actuator component for a drop on demand ink jet printer, said component comprising a body having a top surface, an opening in said top surface extending into said body along an opening axis, an actuator structure located substantially within said opening and an electrode ~~means~~; said electrode ~~means~~ being disposed so as to be able to apply a field to said actuator structure so as to cause said actuator structure to deform.

The paragraphs beginning on page 3, line 10 have been changed as follows:

The shape of the opening may be used to define the shape of the actuator element or additional ~~mould~~ mold elements may be formed in the opening to define the actuator shape that is preferably generally convex or follows the outline of a frustum. The actuator may taper along said opening axis and further comprise a flat portion at the end of said taper; said flat portion comprising an upper surface and a lower surface; said upper and lower surfaces lying parallel with said top and bottom surfaces. The upper surface may lie in the plane of said top

surface. The lower surface may lie within said opening and both the top surface and said bottom surface can move in said opening direction.

Preferably at least a part of the body and ~~mould~~ mold portions that define the actuator shape are removed once the actuator has been formed to enable a freer movement of the actuator though the actuator may remain attached to at least a portion of the body. The removal of this material may be performed by etching or some other technique from the surface of the body opposite the top surface. The opening may then extend through the body with the actuator structure defining an impermeable barrier across it.

The paragraph beginning on page 4, line 19 has been changed as follows:

According to a second aspect of the ~~present~~ invention there is provided a component for ejecting a droplet in a direction of droplet flight, said component comprising an actuator structure displaceable by actuation in the direction of said droplet flight; said actuator defining in part an ejection chamber and comprising a port through which said droplet is ejected.

The paragraphs beginning on page 5, line 12 have been changed as follows:

The opening is etched through the body and a sacrificial ~~mould~~ mold element provided within the opening. This is used, with the body to form a piezoelectric structure by the known technique of ceramic injection ~~moulding~~ molding. The body is then subjected to a high temperature so as to sinter the piezoelectric material. Where the sacrificial ~~mould~~ mold element is a polymeric material this is burned out and removed during the sintering step.

In a particularly elegant form of this method the sacrificial ~~mould~~ mold element is part of the body. Reactive ion etching (RIE) forms a tapered opening that may be used as the ~~mould~~ mold. After the sintering step the body may be etched from the opposite side to release

the piezoelectric structure. Since RIE is a selective process the silicon can be removed without removing the piezoelectric structure.

The paragraphs beginning on page 5, line 27 have been changed as follows:

In a preferred method the body of silicon is reactive ion etched to form the opening. The piezoelectric material is provided in the form of a flexible sheet that is laid against one side of the planar body. The sheet is subsequently subjected to a pressure difference between the opening and the opposite side of the sheet with the lower pressure being located within the opening. A ~~moulding~~ molding feature may be provided within the opening.

The flexible sheet is thus ~~moulded~~ molded into a three dimensional structure and may be fired to sinter the piezoelectric particles in the flexible sheet and burn out the matrix carrier. Electrodes are deposited on the inner and outer surfaces of the formed piezoelectric structure. A diaphragm and / or polymeric material may be deposited to insulate the electrode material from the ink.

According to a further aspect of the ~~present~~ invention there is provided a method of forming a component for an ink jet print head comprising the steps a) providing a body having a ~~mould~~ mold feature, b) forming a deformable actuator structure, the shape of said actuator structure being defined, at least in part by said ~~mould~~ mold feature, c) removing at least a portion of said ~~mould~~ mold feature and d) providing electrode means; said electrode means being disposed so as to be able to apply a field to said actuator structure so as to cause said actuator structure to deform ~~whilst~~ while said actuator structure is attached to said body.

The body provides support to the actuator both in manufacture and use and provides ~~mould~~ mold features for partly defining the shape. The actuator is preferably non planar and may be located within openings provided in the body.

According to yet a further aspect of the ~~present~~ invention there is provided a method of forming a component for an ink jet print head comprising the steps a) providing a body having a top surface, b) forming an opening in said top surface and extending into said body and; c) forming within said opening an actuator structure; said actuator structure remaining attached to said body during actuation.

According to still a further aspect of the ~~present~~ invention there is provided a channelled component for a drop on demand ink jet printer comprising elongate channel walls defining a plurality of elongate liquid channels, each channel comprising one wall that is resiliently deformable in an actuation direction orthogonal to the channel length; a respective ejection nozzle connected with the channel at a point intermediate its length; a liquid supply providing for continuous flow of liquid along said channel; acoustic boundaries at respective opposite ends of the channel serving to reflect acoustic waves in the liquid of the channel wherein the inter-channel spacing of said acoustic boundaries is different to the inter-channel spacing of said nozzles.

In a preferred embodiment the inter-channel spacing of said acoustic boundaries is less than that of the inter-channel spacing of said nozzles. The channels may be ~~chevron shaped~~ chevron-shaped with the chevron angle becoming more acute with increasing distance from a channel that is substantially straight.

On page 8, before line 1 please insert a heading as follows:

BRIEF DESCRIPTION OF THE DRAWINGS

The paragraphs beginning on page 8, line 4 have been changed as follows:

Figure 1a, b and c depict an inkjet component according to the ~~present~~ invention.

Figure 2a and b depict an alternative inkjet component according to the ~~present~~ invention.

The paragraph beginning on page 8, line 17 has been changed as follows:

Figure 11 shows an actuator component according to the ~~present~~ invention.

The paragraph beginning on page 8, line 28 has been changed as follows:

Figures 17a to 17c show an alternative method of manufacture where a body acts as the ~~mould~~ mold and final support component.

On page 9, line 3 please insert a heading as follows:

DETAINED DESCRIPTION

The paragraphs beginning on page 9, line 4 have been changed as follows:

In the ~~Figures~~ figures, like parts are accorded the same reference numerals.

Referring first to Figures 1(a) and 1(b), where Figure 1(b) is a sectional view taken across line X-X of Figure 1(a), a pulsed droplet print head ~~consists of~~ includes a cover component 14 and an actuator component 1, with an ejection chamber 12 defined between these components.

The paragraph beginning on page 10, line 11 has been changed as follows:

By operating the active portion a number of times quickly in succession it is possible to increase the volume of a droplet of fluid ejected from the nozzle. Depending on the mode of operation selected it is possible to either eject additional volumes of ink ~~whilst~~ while a droplet is still attached to a nozzle plate or eject additional volumes of ink in additional,

separate droplets. Because of aerodynamic effects, these additional droplets will usually travel faster than a previously ejected droplet of ink. If the print head operates according to the second mode the later ejected droplets merge with the previously ejected droplet of ink prior to or on its arrival at the substrate. The technique of varying the volume of ink ejected is called greyscale and is described in greater detail in EP-A-0 422 870 (incorporated herein by reference) and consequently will not be described in greater detail.

The paragraph beginning on page 13, line 19 has been changed as follows:

It has been found that the minimal wall thickness at the butting edge can be increased by offsetting the modules as shown in Figure 6, where a neighbouring module is offset by a distance equal to half the module height (as shown in the figure). Each of the outer channels can be inset from the edges of their respective modules, providing a more robust print head ~~whilst~~ while maintaining a constant nozzle pitch across the width of the head.

The paragraph beginning on page 14, line 10 has been changed as follows:

The channels of Figure 8 are fanned outwards from the middle channel in increasingly acute "chevrons["]." A constant nozzle pitch can therefore be achieved albeit at a slightly lower pitch than if the channels were straight. The outer channels are longer than the inner channels and any obvious variations in ejection characteristics may be remedied by forming an acoustic reflection boundary modifier in either the channelled component or actuator component. These modifiers may be an insert or step or some other feature within the chamber.

The paragraph beginning on page 15, line 24 has been changed as follows:

The piezoelectric material is polarised by applying a polarising field between the electrodes to ~~polarise~~ polarize it in the direction depicted by the arrows 5. The planar region 8a is preferably not ~~polarised~~ polarized. The ~~polarised~~ polarized actuator structure thus formed can be caused to deflect to eject a droplet from an ejection chamber by applying a voltage between the electrodes.

The paragraphs beginning on page 16, line 20 have been changed as follows:

Figure 13, a to d depicts a way of manufacturing a component according to the ~~present~~ invention. Firstly, in Figure 13a a silicon body 2 is provided of thickness preferably from 500 microns to 1mm, that has an opening 4 formed therein. The opening is elongate and has a relative dimension of the order 1mm by 60μm.

Inserts 18 are provided that serve to assist the ~~moulding~~ molding process. These are a plastics material that will be removed after or during the forming of the piezoelectric structure and are preferably formed by an injection ~~moulding~~ molding technique. Further mechanical or ablative processes may be required to achieve an appropriate profile.

The paragraphs beginning on page 18, line 1 have been changed as follows:

The piezoelectric structure may be formed by a ~~moulding~~ molding technique as described above with reference to Figure 13, or by laying down multiple thin sheets of the piezoelectric material by vacuum or pressure forming and the like.

After sintering the piezoelectric structure to form the actuator structure, in Figure 14b, portions of the body are etched away to free the piezoelectric structure as shown in Figure 14c. A particularly preferred method of etching is Reactive Ion Etching (RIE). RIE is a selective process in that it will remove the silicon ~~whilst~~ while not affecting the actuator structure. Electrodes are again applied using a known technique.

The paragraph beginning on page 19, line 27 has been changed as follows:

Figures 16 a to c depict a further method of manufacturing the component using flexible green piezoelectric tape or sheets, as now commercially available. The flexible sheet 26 is loosely placed adjacent the bottom surface of the body 2 and a cover plate 28 with a port 30 located on the opposite side of the body. The port is used to subject the opening 4 in the body to reduced pressure that causes the flexible piezoelectric sheet to deform into the opening as in Figure 16c. Alternatively, the other side may be subjected to a high pressure to force the flexible sheet to deform to the shape of a ~~mould~~ mold feature within the opening.

The paragraphs beginning on page 20, lined 10 have been changed as follows:

A further embodiment is depicted with regard to Figures 17a to 17c. In this embodiment, the actuator structure is formed using the body as a support and ~~mould~~ mold feature during manufacture and further as a support during operation of the actuator structure when it is used to eject a droplet. The silicon body is first formed with projections 32, the projections being homogenously silicon or an additional ~~moulding~~ mold component. A piezoelectric material 26 is ~~moulded~~ molded around the projections and then sintered to form the piezoelectric structure 24. Openings 34 are opened in the body behind the fired piezoelectric structure to free it and the projection is similarly removed. As mentioned earlier, the preferred method of removing the projection, where the projection is silicon, is reactive ion etching.

Where the ~~mould~~ mold feature is of a material other than silicon it may be provided by depositing or forming the structure. The material may, for example, be a photoresist. By using such materials it is possible to free the actuator without removing any of the silicon

material. The formed piezoelectric structure may be half tubular and have open ends through which the photoresist is washed.

The paragraph beginning on page 21, line 28 has been changed as follows:

The structure can also be modified as depicted in Figures 19a and 19b. In this embodiment the cover plate of Figure 18 is replaced by a flexible diaphragm incorporating a nozzle plate. ~~Whilst~~ While the diaphragm and nozzle plate have been drawn as separate components it is equally applicable to provide it them as a single component.

The paragraph beginning on page 22, line 13 has been changed as follows:

In an alternative arrangement depicted in Figure 21[.], a hemi-cylindrical piezoelectric structure 6 is formed on a plate 15 serving both as a cover plate and a nozzle plate. The structure 6 may be formed with - for example - one of the techniques described previously, supported during manufacture on photoresist or other sacrificial material subsequently burnt away. Electrodes 7 and 8 formed on the exterior and interior surfaces of the piezoelectric structure serve during manufacture to polarise the piezoelectric material in the arrowed direction and also serve in use to apply the actuating fields. The thickness of the piezoelectric structure is preferably around 15 microns with a channel width of around 200 microns and length around 1mm. The thickness of the cover/nozzle plate may be between 25 and 125 microns with a nozzle 16 of between 25 and 50 microns. If appropriate, the nozzle may be formed in a separate nozzle plate bonded to a somewhat thicker cover plate.